REMARKS

Overview of the Office Action

Claims 1 and 4-5 have been rejected under 35 U.S.C. §102(b) as anticipated by "The Formation of Crystalline defects..." by Kawaguchi et al. ("Kawaguchi").

Claims 2 and 6-12 have been rejected under 35 U.S.C. §103(a) as unpatentable over Kawaguchi in view of Applicants' Admitted Prior Art ("AAPA").

Claims 13-17 and 34 have been rejected under 35 U.S.C. §103(a) as unpatentable over Kawaguchi in view of "InGaN-Based Blue Light Emitting Diodes..." by Mukai ("Mukai").

Claims 1, 4, 5, 13-17, 34 and 35 have been rejected under 35 U.S.C. §103(a) as unpatentable over "Pit formation in GaInN quantum wells" by Chen et al. ("Chen") in view of U.S. Patent No. 6,555,846 ("Watanabe").

Claims 2 and 6-12 have been rejected under 35 U.S.C. §103(a) as unpatentable over Chen in view of Watanabe, and further in view of AAPA.

Status of the claims

Claims 1 and 35 have been amended.

Claims 3 and 18-33 have previously been canceled.

Claims 1-2, 4-17 and 34-35 remain pending.

Rejection of claims 1 and 3-5 under 35 U.S.C. §102(b)

The Office Action states that Kawaguchi teaches all of Applicants' recited elements.

Independent claim 1 has been amended to recite a method for fabricating a light-emitting device, wherein "wherein the light-emitting device is Indium free, and the light-emitting layer

comprises $Al_yGa_{1-y}N$, where $0 < y \leq 1$", which Kawaguchi fails to teach or suggest. Support for the amendment to claim 1 can be found in paragraph [0026] of Applicants' specification.

Applicants' recited invention is directed to a method for fabricating a light-emitting device that is Indium free. The steps include forming at least one compound semiconductor layer based on gallium nitride. The at least one compound semiconductor layer is an active layer 2 (i.e., light-emitting layer). Applicants' light-emitting layer 2 is generally formed from an $In_x Al_yGa_{1-x-y}N$ compound semiconductor, where $0 \leq x \leq 1$, $0 \leq y \leq 1$ and $x+y \leq 1$. In particular, however, according to Applicants' recited method, the light-emitting layer 2 is formed from an $Al_yGa_{1-y}N$ compound semiconductor where $x = 0$, and $0 < y \leq 1$ (i.e., the light-emitting layer 2 is Indium free) (see paragraph [0026] of Applicants' specification).

Applicants' recited method further includes setting growth parameters used during production of the compound semiconductor layer such that, at least in some cases in a vicinity of dislocations in the compound semiconductor layer, regions are produced in the compound semiconductor layer having a lower thickness than remaining regions of the compound semiconductor layer. The regions with the lower thickness are formed to be less than half as thick as the remaining regions of the compound semiconductor layer in the final structure of the light-emitting device.

Applicants' device also includes a first n-conducting coating layer 3 formed from $Al_uGa_{1-u}N$ where $0 < u \leq 1$, and a p-conducting second coating layer 4 formed from $Al_vGa_{1-v}N$ where $0 < v \leq 1$. The composition of the compound semiconductor in both the first and second coating layers 3, 4 differs from the composition of the compound semiconductor in the light-emitting layer 2.

Kawaguchi is concerned with the relationship of crystalline defects and compositional inhomogeneity to the lattice mismatch in $In_xGa_{1-x}N$ layers grown on GaN epitaxial layers (see

page 25, left column. second paragraph of Kawaguchi). Hence, the device described by Kawaguchi is not Indium free. Further, the device described by Kawaguchi includes a light-emitting layer formed from $In_xGa_{1-x}N$ and not from $\underline{Al_vGa_{1-v}N}$, as recited in Applicants' amended claim 1 (see Figs. 3, 4(a) and 4(b) of Kawaguchi). Therefore, Kawaguchi clearly fails to teach or suggest Applicants' recited invention.

Further, even if a person skilled in the art were to produce an Indium free light-emitting device by replacing the InGaN layer of Kawaguchi with an AlGaN layer, the result would still not be a light-emitting device as recited in Applicants' claims because Kawaguchi also fails to teach or suggest purposely setting growth parameters to form the regions at the bottom of the pits in the active layer with a particular thickness, as also recited in Applicants' claims.

The various results described by Kawaguchi (e.g., pit formation) are inherent to the materials and methods used by Kawaguchi. Therefore, a person skilled in the art and replacing, for the sake of argument, the InGaN layer of Kawaguchi with an AlGaN layer would obtain an AlGaN layer with qualities different from those of the InGaN layer, even if the same growth methods were employed. Further, using the methods of Kawaguchi, which do not include purposely setting growth parameters to produce regions with a lower thickness that is less than half as thick as the remaining regions of the compound semiconductor layer (as applicants' claims recite), to grow an AlGaN layer instead of an InGaN layer will not itself guarantee that such regions of lower thickness will actually be formed with applicants' recited thickness that is less than half as thick as the remaining regions of the compound semiconductor layer.

In response to Applicants' previous arguments that Kawaguchi fails to teach or suggest that the regions of lower thickness are formed to be less than half as thick as the remaining regions of the compound semiconductor layer in the final structure of the light-emitting device, the Examiner appears to interpret Kawaguchi as teaching some intermediate growth stage that is

between the initial growth stage described at page 25 of Kawaguchi and the next growth stage described at page 27 of Kawaguchi.

According to the Examiner, in the initial grown stage a 100 nm thick InGaN layer is grown to form the "Region I" shown in Fig. 4a of Kawaguchi, which includes pits of 30 nm, which results in a region of lesser thickness of 70 nm. Next, the Examiner asserts that Figs. 4b and 2c show that an additional InGaN layer (still Region I) is grown atop the horizontal top surface of the Region I InGaN layer shown in Figs. 4a and 2b of Kawaguchi, and that the height of the pit has increased to 500 nm, while the region of lesser thickness has remained at 70 nm. The Examiner further asserts that since the top of the pit is at 500 nm and the bottom of the pit is still at 70 nm, the total thickness of the layer is 570 nm, and that region of lesser thickness is less than half the thickness of the remaining region. Applicants submit that the Examiner's interpretation and reading of Kawaguchi is not supported by the reference teachings and disclosure.

According to Kawaguchi, in the initial growth stage the InGaN layer (i.e., Region I) was 100 nm and the depth of the pits was 30 nm (see Fig. 1a and page 25, col. 1, "Results and discussion" of Kawaguchi). Thus, the remaining region (i.e., the portion under the pit) is 70 nm (i.e., 100-30), which is greater than half the thickness of the InGaN layer. When the layer thickness was increased to 2000 nm in the initial growth stage, the height of the top of the pyramid from the valley of the pit was 300 nm (see Fig. 1b and the last two lines of page 25, col. 1 to the end of the first paragraph of col. 2 of the "Results and discussion" of Kawaguchi). Thus, the remaining region is 1700 nm (i.e., 2000-300), which again is greater than half the thickness of the InGaN layer.

Figs. 2a and 2b of Kawaguchi are TEM images of the structure after the initial growth stage (see page 25, second col., last paragraph of Kawaguchi).

Fig. 2c corresponds to the next growth stage where the second InGaN layer (i.e., Region II) is grown on the first InGaN layer (Region I) (see page 27, first column, second paragraph, lines 1-5 of Kawaguchi). Fig. 2d of Kawaguchi is simply an expanded view of Fig. 2c.

Figs. 2c and 2d thus do <u>not</u> correspond to some intermediate growth stage that increases the thickness of Region I, as asserted by the Examiner.

According to Kawaguchi, Fig. 2c simply shows that the pits are 500 nm deep after the <u>next growth stage</u> (i.e., growth of Region II) (see page 27, col. 1, second paragraph of Kawaguchi) in which additional InGaN is grown on the already 2000 nm thick InGaN layer. Kawaguchi does not indicate how much InGaN is grown in this next growth stage. However, given the thickness of the InGaN layer from the initial growth stage (i.e., 2000 nm), the remaining region is at least 2000 nm – 500 nm (pit depth), or 1500 nm, which is <u>more than half</u> of the remaining region of the InGaN layer.

Moreover, as clearly shown in Fig. 2d, the regions of lower thickness are in no way formed to be less than half as thick as the remaining regions of the compound semiconductor layer, as recited in Applicants' claim 1.

Figs. 4a and 4b are simple schematic representations of Figs. 2c and 2d. Fig. 4a of Kawaguchi shows a first InGaN layer (Region I) grown on a GaN layer. No thickness of the InGaN layer is described and no depth of the pits is stated. Fig. 4b shows a second InGaN layer (Region II) grown on top of Region I. Again, no thickness of the InGaN layer is set forth and no depth of the pits is recited.

Furthermore, as described in Applicants' specification, if stresses and piezoelectric fields are deliberately incorporated in Indium free light-emitting diodes, it is possible, by targeted control of the growth with a view to achieving a smaller thickness of the light-emitting layers in the vicinity of dislocations, to produce a light-emitting diode with a sufficient light yield (see

paragraph [0040] of Applicants' specification).

Therefore, within Indium free light-emitting devices with a light-emitting layer that is formed from $Al_yGa_{1-y}N$, the lower thickness in the vicinity of dislocations is not achieved automatically, but must instead be purposely implemented.

Kawaguchi accordingly fails to teach or suggest "wherein the regions with the lower thickness are formed to be less than half as thick as the remaining regions of the compound semiconductor layer in the final structure of the light-emitting device", as recited in Applicants' amended independent claim 1.

In view of the foregoing, Applicants submit that Kawaguchi fails to teach or suggest the subject matter recited in Applicants' amended independent claim 1 and, accordingly, claim 1 is deemed to be patentable over Kawaguchi under 35 U.S.C. §102(b).

Dependent claims

Claims 3-5, which depend from independent claim 1, incorporate all of the limitations of independent claim 1 and are, therefore, deemed to be patentably distinct over Kawaguchi for at least those reasons discussed above with respect to independent claim 1.

Rejection of claims 2 and 6-12 under 35 U.S.C. §103(a)

The Office Action further states that the combination of Kawaguchi and the AAPA teaches all of Applicants' recited elements.

Kawaguchi has been previously discussed and does not teach or suggest the invention recited in Applicants' independent claim 1.

Because Kawaguchi does not teach or suggest the subject matter recited in amended independent claim 1, and because the AAPA does not teach or suggest any elements of

independent claim 1 that Kawaguchi is missing, the addition of the AAPA to the reference combination fails to remedy the non-obviousness of that claim.

Claims 2 and 6-12, which depend from independent claim 1, incorporate all of the limitations of independent claim 1 and are, therefore, deemed to be patentably distinct over Kawaguchi and the AAPA for at least those reasons discussed above with respect to independent claim 1.

Rejection of claims 13-17 and 34 under 35 U.S.C. §103(a)

The Office Action further states that the combination of Kawaguchi and Mukai teaches all of Applicants' recited elements.

Kawaguchi has been previously discussed and does not teach or suggest the invention recited in Applicants' independent claim 1.

Because Kawaguchi does not teach or suggest the subject matter recited in amended independent claim 1, and because Mukai does not teach or suggest any elements of independent claim 1 that Kawaguchi is missing, the addition of Mukai to the reference combination fails to remedy the non-obviousness of that claim.

Claims 13-17 and 34, which depend from independent claim 1, incorporate all of the limitations of independent claim 1 and are, therefore, deemed to be patentably distinct over Kawaguchi and Mukai for at least those reasons discussed above with respect to independent claim 1.

Rejection of claims 1, 4, 5, 13-17, 34 and 35 under 35 U.S.C. §103(a)

The Office Action additionally states that the combination of Chen and Watanabe teaches all of Applicants' recited elements.

As previously mentioned, independent claim 1 has been amended to recite a method for fabricating a light-emitting device, wherein "wherein the light-emitting device is Indium free, and the light-emitting layer comprises $Al_yGa_{1-y}N$, where $0 < y \leq 1$", which Chen and Watanabe, whether taken alone or in combination, fail to teach or suggest.

Chen is concerned with the study of the formation of pits in GaInN quantum wells (see Abstract of Chen). Chen mentions nothing regarding an Indium free light-emitting device with a light-emitting layer that is formed from an $Al_yGa_{1-y}N$ compound semiconductor.

Watanabe discloses a group III nitride semiconductor device ($In_xGa_{1-x-y}Al_yN$), which has a reduced number of threading dislocations adversely affecting characteristics of the group III nitride semiconductor device. Watanabe also discloses a method for manufacturing group III nitride semiconductor devices that control pit formation in a GaN layer on a sapphire substrate (see abstract of Watanabe).

The device of Watanabe includes a multilayer structure in which nitride semiconductor single-crystal layers are formed on a sapphire substrate 1. A low temperature buffer layer 2 of AlN is formed on the sapphire substrate 1 of Watanabe. A non-doped GaN crystal layer 3 is formed on the low-temperature buffer layer 2 as a first GaN layer. The non-doped GaN crystal layer 3 takes on an island-like structure without any dopant. A second GaN layer 4 containing a dopant is formed on the first GaN layer. The second GaN layer 4 is deposited while filling pyramidal surface voids in the first GaN layer 3 and flattening the surface of the GaN layer 3. A non-doped GaN crystal film 5 is formed on the second GaN layer 4 as a third GaN layer. A crystal layer 6 is formed on the GaN crystal film 5. Furthermore, an n-type cladding layer 7, an active layer 8, a p-type cladding 9, and a p-type contact layer 10 are formed in the stated order on the layer 6. Then, a p-type electrode 11 and an n-type electrode 12 are formed on the p-type contact layer 10 and the fourth crystal layer 6, respectively (see col. 3, lines 28-51 of Watanabe).

Watanabe is silent regarding the composition of the active layer 8. Therefore, Watanabe also fails to teach or suggest "wherein the light-emitting device is Indium free, and the light-emitting layer comprises $Al_yGa_{1-y}N$, where $0 < y \leq 1$", as recited in Applicants' amended claim 1.

Consequently, because neither Chen nor Watanabe teach or suggest "wherein the light-emitting device is Indium free, and the light-emitting layer comprises $\underline{Al_yGa_{1-y}N}$, where $0 < y \leq 1$", as recited in Applicants' amended claim 1, the combination of these references also fails to teach or suggest Applicants' recited invention.

Independent claim 35 has been correspondingly amended to recite limitations similar to those of independent claim 1 discussed above and is, therefore, deemed to be patentably distinct over Chen and Watanabe for at least those reasons discussed above with respect to independent claim 1.

In view of the foregoing, Applicants submit that Chen and Watanabe fail to teach or suggest the subject matter recited in Applicants' amended independent claims 1 and 35. Accordingly, claims 1 and 35 are deemed to be patentable over Chen and Watanabe under 35 U.S.C. §103(a).

Dependent claims

Claims 4, 5, 13-17 and 34, which depend from independent claim 1, incorporate all of the limitations of independent claim 1 and are, therefore, deemed to be patentably distinct over Chen and Watanabe for at least those reasons discussed above with respect to independent claim 1.

Rejection of claims 2 and 6-12 under 35 U.S.C. §103(a)

The Office Action further states that the combination of Chen, Watanabe and the AAPA teaches all of Applicants' recited elements.

Chen and Watanabe have been previously discussed and do not teach or suggest the invention recited in Applicants' independent claim 1.

Because Chen and Watanabe do not teach or suggest the subject matter recited in amended independent claim 1, and because the AAPA does not teach or suggest any elements of independent claim 1 that Chen and Watanabe are missing, the addition of the AAPA to that reference combination fails to remedy the non-obviousness of that claim.

Claims 2 and 6-12, which depend from independent claim 1, incorporate all of the limitations of independent claim 1 and are, therefore, deemed to be patentably distinct over Chen, Watanabe and the AAPA for at least those reasons discussed above with respect to independent claim 1.

Conclusion

In view of the foregoing, reconsideration and withdrawal of all rejections, and allowance of all pending claims, are respectfully solicited.

Should the Examiner have any comments, questions, suggestions, or objections, the Examiner is respectfully requested to telephone the undersigned to facilitate an early resolution of any outstanding issues.

Respectfully submitted,
COHEN PONTANI LIEBERMAN & PAVANE LLP

By ______________________________

Lance J. Lieberman
Reg. No. 28,437
551 Fifth Avenue, Suite 1210
New York, New York 10176
(212) 687-2770

Dated: August 28, 2008